TITLE OF THE INVENTION

Measuring arrangement for testing workpieces, and a method for metrological instrumentation of workpieces

BACKGROUND AND SUMMARY OF THE INVENTION

This application claims the priority of German Application No. 10238862.8, filed August 24, 2002, the disclosure of which is expressly incorporated by reference herein.

The invention relates to a measuring arrangement for testing workpieces and to a method for metrological instrumentation of workpieces.

Fiber-optic Bragg grating sensors are known from metrology. A permanent increase in refractive index along the axis of an optical fiber is produced at freely selectable points in a core thereof by means of a structured exposure of an optical fiber - also termed optical conductor - with the aid of UV light. The modulation in the resulting refractive index of the optical ~~fibre~~ fiber ~~thereby yielded~~ fiber is variable in respect of its length of period, amplitude and overall length. This structure is denoted as a Bragg grating and is metrologically useful. Such Bragg grating sensors known from the prior art can be used as strain sensors and/or temperature sensors.

Starting herefrom, the present invention is based on the problem of providing a measuring arrangement for testing workpieces, and a method for metrological instrumentation of workpieces.

This problem is solved by means of a measuring arrangement for testing workpieces ~~in accordance with Claim 1~~ having at least one optical fiber assigned to a workpiece, in which the or each optical fiber is designed as a Bragg grating sensor, and in which the or each optical fiber is arranged in the region of a surface of the workpiece. The method according to the invention for

metrological instrumentation of workpieces ~~is characterized by the features of independent Claim 12~~ wherein at least one optical fiber designed as a Bragg grating sensor is arranged in the region of a surface of the workpiece.

The outlay on instrumentation for the component can be reduced substantially by the inventive use of the optical fibers designed as a Bragg grating sensor. There is likewise a reduction in the effects of instrumentation which can impair the behaviour of the component during the test or when being ~~trailed~~ used. Again, when use is made of the optical fibers designed as a Bragg grating sensor, it is possible to increase the number of measuring points, as a result of which test results are rendered ~~yet~~ more informative.

~~The or~~ Each optical fiber designed as a Bragg grating sensor is preferably mounted, in particular bonded, directly on the surface of the workpiece. This permits a metrological instrumentation of the component in a particularly simple way.

According to an alternative advantageous development of the invention, ~~the or~~ each optical fiber designed as a Bragg grating sensor is integrated in the surface of the workpiece, ~~there being~~ with recesses introduced into the surface of the workpiece recesses whose width and depth are matched to the diameter of the optical fibers designed as Bragg grating sensors~~,~~. ~~and~~ ~~a~~An optical fiber being arranged in the recesses. This minimizes the effects of instrumentation on the component to be trailed.

According to a preferred development of the invention, a plurality of optical fibers designed as Bragg grating sensors are arranged in a different geometrical configuration on a surface of the workpiece, specifically with different curvatures. It is possible thereby to accomplish optimized placing of the measuring points with particularly simple means.

BRIEF DESCRIPTION OF THE DRAWING

~~Preferred developments of the invention emerge from the dependent subclaims and the following description~~. Exemplary embodiments of the invention are explained in more detail with the aid of the drawing, in which~~:~~

Figure 1 shows a diagrammatic illustration of the inventive measuring arrangement for testing workpieces.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A workpiece 10 with metrological instrumentation is illustrated very diagrammatically in Figure 1~~,~~. ~~the~~The workpiece 10 ~~being~~ is a blade of a turbine. However, the workpiece 10 can also be other dynamically loaded components of a turbine, for example a housing part or the like.

In accordance with Figure 1, a plurality of optical fibers 11, 12, 13, 14, 15, 16, 17 and 18 designed as Bragg grating sensors are arranged in the region of a surface of the workpiece 10.

Two first optical fibers 11, 18, which are both designed as Bragg grating sensors, are positioned without curvature in the form of a straight line on the surface of the workpiece 10. In accordance with Figure 1, these optical fibers 11, 18 are assigned to an outer edge region of the workpiece 10, specifically the turbine blade. A second optical fiber 12, 17 is positioned in each case next to these two first optical fibers 11, 18. The two second optical fibers 12, 17 are arranged in accordance with Figure 1 on the surface of the workpiece 10 in such a way that the same have an angular course, a first section of these fibers 12, 17 running approximately parallel to the first optical fibers 11, 18 and a second section of the same being designed angled off from this first section. A total of four third optical fibers 13, 14, 15 and 16, which are designed as Bragg grating sensors, are positioned on the surface of the

workpiece 10 between the two second optical fibers 12, 17. The third optical fibers 13, 14, 15 and 16 have in common that ~~the same in each case~~ they each have a curved section in which the optical fiber 13, 14, 15 and 16 is angled off at approximately 180°. Consequently, neighbouring sections of an optical fiber 13, 14, 15 and 16 run approximately parallel to one another in the region of the curved section. As may be gathered from Figure 1, the curved sections of the third optical fibers 13, 14, 15 and 16 differ with respect to their radii of curvature. The optical fiber 13 has a curved section 19, the radius of curvature of the curved section 19 corresponding to a unit of measurement. A radius of curvature of the curved section 20 of the optical fiber 16 corresponds to two units of measurement. Consequently, a curved section 21 of the optical fiber 14 has a radius of curvature of three units of measurement, and a curved section 22 of the optical fiber has a radius of curvature of five units of measurement. The larger the radius of curvature of the curved sections, the further spaced apart from one another are the sections of the optical fibers 13, 14, 15 and 16 which run approximately parallel to one another in the region of the curved sections. As may also be gathered from Figure 1, two of the third optical fibers 21, 22 have an additional curved section of approximately 90° in addition to the curved section of approximately 180°.

Consequently, a plurality of optical fibers 11, 12, 13, 14, 15, 16, 17 and 18, designed as Bragg grating sensors, are arranged on the surface of the workpiece 10 in a different geometrical configuration and with different curvatures. The optical fibers 11, 12, 13, 14, 15, 16, 17 and 18, designed as Bragg grating sensors, can in this way be arranged on the workpiece 10 such that a multiplicity of different measuring points can be realized with particularly simple structural means.

According to a first advantageous alternative for developing the invention, the optical fibers 11, 12, 13, 14, 15, 16, 17 and 18 are bonded directly on the surface of the workpiece. For this purpose, the optical fibers can

be mounted on the workpiece with the aid of an adhesive, for example, which is normally used for mounting strain gauges. Again, the optical fibers can be bonded on the surface of the workpiece 10 with the aid of known lamination methods.

It is also possible, as an alternative, ~~to this~~ for the optical fibers 11, 12, 13, 14, 15, 16, 17 and 18 to be integrated into the surface of the workpiece 10. In this case, recesses which preferably have a width of 0.2 to 0.25 mm and a depth of 0.3 mm are introduced into the surface of the workpiece 10. The recesses are consequently matched with regard to their width and depth to the diameter of the optical fibers 11, 12, 13, 14, 15, 16, 17 and 18 designed as Bragg grating sensors. Moreover, the course of the recesses corresponds to the geometrical configuration with which the corresponding optical fiber is to be attached to the surface of the workpiece 10. The recesses therefore run either rectilinearly or in a curved shape or the shape of a circular arc.

Instrumentational influences on the workpiece can be minimized by the integration of the optical fibers designed as Bragg grating sensors into the surface of the workpiece 10.

It is particularly advantageous to use the measuring arrangement according to the invention on dynamically loaded components such as on turbine blades, for example. Vibrations and temperatures can be measured with the aid of the optical fibers designed as Bragg grating sensors. The influence exerted on the component as a consequence of the instrumentation or the arrangement of the optical fibers designed, as Bragg grating sensors is minimal. A novel measurement technique is introduced into the development and trailing of turbines within the scope of the invention. Such a metrological design is particularly robust and has a long service life.

In the case of the inventive method for metrological instrumentation of workpieces, at least one optical fiber, which is designed as a Bragg grating sensor, is arranged in the region of a surface of the workpiece. It is possible again in this case for the optical fibers either to be bonded directly on the surface of the workpiece with the aid of a bonding technique or via a lamination method, or else for them to be integrated into the surface of the workpiece using encapsulation technology.

It is likewise possible to use optical fibers in order to pick off the measured values from the optical fibers designed as Bragg grating sensors, and to pass on the measured values to an electronic evaluation system. In the case where the workpiece 10 to be ~~trailed~~ <u>used</u> is a turbine blade, these optical fibers can be guided through a blade root to pass on the measured values. The effect of this is to relieve the stress on the optical fibers.

Further geometrical configurations of the optical fibers are conceivable beyond the geometrical configuration, shown in Figure 1, of the optical fibers 11, 12, 13, 14, 15, 16, 17 and 18. Thus, the optical fibers can also be guided diagonally over a workpiece to be trailed.

High-temperature stable or polyimide-coated glass fibers, which are designed as Bragg grating sensors, are preferably used as optical fibers.

List of reference numerals

Workpiece	10
Optical fiber	11
Optical fiber	12
Optical fiber	13
Optical fiber	14
Optical fiber	15
Optical fiber	16
Optical fiber	17
Optical fiber	18
Curved section	19
Curved section	20
Curved section	21
Curved section	22

Abstract of the Disclosure

A measuring arrangement for testing workpieces, having at least one optical fiber (11, 12, 13, 14, 15, 16, 17, 18) assigned to a workpiece (10), in which or each the optical fiber (11, 12, 13, 14, 15, 16, 17, 18) is designed as a Bragg grating sensor, and in which the or each optical fiber (11, 12, 13, 14, 15, 16, 17, 18) is arranged in the region of a surface of the workpiece.